ORDA Clutter Filtering Options Assessment and Recommendation

Abstract

The use of the SIGMET RVP8 Digital Signal Processor in the ORDA design introduces additional clutter suppression options to the WSR-88D radar system. However, the WSR-88D System Specification and NEXRAD Technical Requirements (NTR) contain specific, performance-related, clutter-suppression requirements that must be verified before the existing SIGMET capabilities are implemented in the WSR-88D radar system. The WSR-88D radar system currently has a time domain, 5th-order, elliptic Infinite Impulse Response (IIR) filter. The SIGMET RVP8 Digital Signal Processor provides two different types of clutter suppression filters. The first is a time domain, 4th-order Chebyshev IIR filter. The second is a set of frequency domain, Fast Fourier Transform (FFT), adaptive, clutter suppression filters. A series of SIGMET Digital Signal Simulator (DSS) clutter signals were used to evaluate the performance of the existing SIGMET IIR and FFT clutter suppression filters. This report summarizes the performance achieved with SIGMET's 4th-order, IIR filter, and with SIGMET's FFT filters. The effectiveness of the SIGMET clutter filters, with respect to WSR-88D performance requirements, is provided in this report. Finally, a recommendation for the clutter suppression technique to be used in the ORDA design is presented at the end of the report.

Dale Sirmans, Nita Patel, and Roland Leatherman
National Weather Service - Radar Operations Center,
Office of Science and Technology - Open RDA project Norman, OK 73069

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1. Introduction

The SIGMET signal processor offers a choice of clutter filtering in either the time or frequency domain [1]. The frequency domain technique uses a Fast Fourier Transform (FFT) with heuristic filters that operate on the power spectra. The time domain technique uses a 4^{th}-order, Chebyshev Infinite Impulse Response (IIR), high-pass filter providing stop-band attenuation of either 40dB or 50dB and seven stop-band widths (stop-bands) ranging from approximately 2% to 14% of the Nyquist co-interval.

Use of the SIGMET signal processor in the ORDA provides several options for clutter suppression. Options include implementation of the legacy 5^{th}-order filter, use of the frequency domain heuristic filter, or use of the 4^{th}-order, recursive IIR filter. The SIGMET filters were developed for commercial application; therefore, they have not been evaluated for compliance to the NEXRAD Technical Requirements (NTR) [2] or suitability for WSR-88D operational application. The following sections will provide an assessment of the SIGMET filters, compliance to NTR performance criteria and will provide a comparison against the legacy, clutter filter performance.

2. Clutter Suppression General Requirements

The NEXRAD Technical Requirements [2] establishes general clutter suppression requirements applicable to any suppression method used. The NTR also defines the clutter model and parameters to be used for testing against these requirements. Clutter Model A, as defined by the NTR, is a Gaussian random process with Gaussian spectrum centered at zero mean velocity. Model A's mean velocity has a standard deviation of

$0.1ms^{-1}$ plus the spectrum width resulting from the antenna rotation rate at the lowest two elevations angles (NTR 3.7.1.7). Imposing requirements of NTR 3.7.1.2.3 results in a clutter model having zero mean and Gaussian spectrum with standard deviation of 0.32 ms^{-1} at the WSR-88D median wavelength. This is the model used to provide the test results in this report. NTR requirements for clutter Model B is a strong point target not applicable to this testing.

Important general requirements for clutter suppression are maximum suppression and bias in reflectivity and velocity estimates due to the clutter suppression. Required suppression is given in NTR 3.7.1.7.1 and is summarized in Table 1.

Minimum Usable Mean Radial Velocity, ms^{-1} (See Sec. 3.7.1.7.2)	Required Ground Clutter Suppression Capability (I) in dB at: Spectrum Width = $4ms^{-1}$	
	Clutter Model A	Clutter Model B
2	20	20
3	28	30
4	50	50

Table 1. Clutter Suppression Requirements for Mean Radial Velocity and Spectrum Width Estimates.

The minimum usable velocity is defined in NTR 3.7.1.7.2 as the velocity at which the clutter suppression induced bias in mean velocity and spectrum width is less than or equal to $2ms^{-1}$. Maximum bias in reflectivity estimates due to clutter suppression is given in NTR 3.7.1.7.2 and is summarized in Table 2.

Weather Spectrum Width (W) (ms^{-1})	Maximum Allowable Bias in Reflectivity Estimate (dB)
1	10
2	2
≥ 3	1

Table 2. Maximum Allowable Bias in Reflectivity Estimates Due To Clutter Suppression.

Minimum usable velocity and maximum reflectivity bias jointly constrains the filter notch-width [3]. With filters [such as the spectral processing FFT or the 5th-order elliptic IIR (legacy)] having a sharp transition from stop-band to pass-band, maximum velocity bias occurs at an input velocity approximately three-fourths the notch half-width and has a magnitude of approximately 1.75 ms^{-1} for spectrum widths greater than 2ms^{-1} [3].

Reflectivity bias requirements are more stringent with filters such as the legacy, IIR or the spectral-processing FFT filters. Reflectivity bias exceeds 10 dB for notch half-widths greater than 1.75 ms^{-1} and input spectrum widths less than or equal to 1 ms^{-1} at zero mean velocity

The NTR requires three, operator-selectable, levels of suppression compliant with Table 1. (NTR 3.7.1.7.1). (These are referred to as the low, medium and high suppression filters in the referenced documentation). At the WSR-88D wavelength, the filters have corresponding notch half-widths of 0.875 ms^{-1}, 1.25 ms^{-1} and 1.75 ms^{-1} for the surveillance filters and 1.1825 ms^{-1}, 1.5625 ms^{-1} and 2.3125 ms^{-1} for the Doppler filters.

3. Frequency Domain Clutter Filter Analysis

The frequency domain clutter filtering method is discussed in the SIGMET Manuals [1] and only the salient features of the filter type selected for evaluation are repeated here. The variable width, single slope filter (Type 1) was selected for the WSR-88D application.

In general, frequency domain filter performance is determined by several factors. Two important factors are the time window function used in the DFT and the number of samples available for the DFT. High suppression of 50 dB and greater requires a strong window function such as the Gaussian or the Blackman. The Blackman window is the most aggressive offered in the standard Sigmet signal processor and was selected for this evaluation. The number of samples is dictated by the radial interval (1 degree in this case), the radar PRF, and the antenna rotation rate. For the legacy, convective-mode volume coverage patterns (VCP) the number of samples varies from 16 to 28 for the contiguous surveillance scans and from 40 to 111 for the contiguous Doppler scans.

Presently, the SIGMET signal processor uses FFTs instead of DFTs for power spectra calculations. The computations accommodate a variable number of samples by overlapping two 2^n sample sets that encompass the available samples. The number of samples available and the FFT accommodation of these samples result in a constraint on the filter flexibility. Table 3 shows how the FFT filter behaves with VCP-11 across the 2.7 GHz to 3.0 GHz frequency band.

		λ =10 cm		λ =11 cm			
	PRF(Hz)	Va Min(ms^{-1})	Va Max(ms^{-1})	ΔVc Min(ms^{-1})	ΔVc Max(ms^{-1})	Ns	Nc
1	322	8.05	8.86	1.01	1.11	16	16
2	446	11.15	12.27	5.5.7	6.14	6	4
3	644	1611	17.71	4.02	4.42	10	8
4	857	21.43	23.57	0.67	0.74	34	32
5	1014	25.35	27.89	1.58	1.74	41	32
6	1095	27.38	30.12	1.71	1.88	43	32
7	1181	29.53	32.48	1.85	2.03	42	32
8	1282	32.05	35.26	2.00	2.20	50	32

Table 3. FFT Spectral Processing Parameters in relation to WSR-88D, VCP-11.

For table 3,

λ= Wavelength,

PRF = pulse repetition frequency,

Va= Nyquist velocity,

ΔVc = spectral coefficient spacing,

Ns= number of samples available,

Nc= Number of coefficients in FFT.

Note that ΔVc ranges from 1.06 ms^{-1} to 2.1 ms^{-1} depending on radar wavelength and PRF (exceptions are items 2 and 3 which are used with only batch waveforms in convective mode and item 4 which is noncompliant with NTR performance requirements.) As a result, the surveillance filter notch half-width or stop-band half-width can only be selected in increments of 1.06 ms^{-1} . The Doppler filter increment ranges from 1.66 ms^{-1} to 2.1 ms^{-1} ,depending on the radar wavelength and PRF.

The filter selected for most of the detailed examination is designated as filter 1221 in this report. The first digit (1) represents the type of filter; in this case, variable-width, single slope. The second digit (2) represents the "width" of the filter (e.g. a width of 2 removes the DC coefficient (zero velocity) and one coefficient on either side of zero velocity). The third digit (2) is the number of endpoints used for the linear interpolating line to reconstruct the spectra after suppression. The fourth digit (1) is the "hunt" parameter. The hunt parameter extends the filter notch beyond the initial width of this heuristic filter in order to capture most of the clutter power. Filter 1221 has a notch half-width of 1.59 ms^{-1} for surveillance and 2.65 ms^{-1} for Doppler. For the high suppression test parameters given in table 4 and 5, filter 1221 has a notch half-width of 2.49 ms^{-1} for surveillance and 4.15 ms^{-1} for Doppler. These notch half-widths compare to the legacy values of 1.75 ms^{-1} for surveillance and 2.31 ms^{-1} for Doppler.

Table 4 shows the amount of clutter suppression achieved with filter 1221. Parameters for the lowest two elevation angles of VCP-21 and VCP-11 are used with input clutter velocity of 0 ms^{-1} and width of 0.27 ms^{-1}. A width of 0.27 ms^{-1} was the closest value to the NTR specified value of 0.32 ms^{-1} that was available from the SIGMET signal simulator.

PRF (Hz)	Filter	Ns	ΔVc (ms^{-1})	Vp (ms^{-1})	Suppression (dB)
322	1221	16	1.06	1.59 or 2.65	53
322	1221	28	1.06	1.59 or 2.65	53
1014	1221	52	1.66	2.49 or 4.15	51
1014	1442	88	0.88	2.08 or 3.76	66

Table 4. Suppression Achieved with Spectral Processing, filter 1221.

For Table 4,

Notation same as Table 3,

Vp= notch half-width,

Clutter width = 0.27 ms^{-1},

Ns = Number of Samples.

Note that maximum suppression requirements in Table 2 are satisfied with filter 1221.

Reflectivity bias values for varying input widths are given for the high suppression ($\geq$ 50dB) in Table 5.

			Bias (dB) at Input Width (ms^{-1})			
PRF (Hz)	Ns	Filter	1 ms^{-1}	2 ms^{-1}	3 ms^{-1}	4 ms^{-1}
322	16	1221	14.3	7.5	3.4	1.6
322	28	1221	10.7	2.6	1.4	2.5
1014	52	1221	22.4	6.3	4.4	2.2
1014	88	1442	37.2	12.9	4.3	2.8

Table 5. Reflectivity Bias for varying input widths with Spectral Processing and Suppression $\geq$ 50dB

Reflectivity bias requirements (referenced in Table 1) are not satisfied with filter 1221. The number of samples available has little effect on suppression achieved as long as the number of samples in the DFT is the same as the number of samples available (note the first two rows of Table 4). The number of samples reduces the reflectivity bias, particularly for the smaller spectrum widths, as can be seen from the first two rows of data in Table 5.

Examination of the last two rows of Table 4 and 5 reveals several aspects of the spectra filters. The amount of suppression achieved and the bias present indicate that the filter chose a notch half-width of 2.49 ms^{-1} for 52 samples and a notch half-width of 3.76 ms^{-1} for 88 samples.

The data shows that a notch half-width of 2.49 ms^{-1} provides 51dB of suppression, 2.65 ms^{-1} provides 53dB of suppression, and 3.76 ms^{-1} provides 66dB of suppression. Therefore, a minimum notch half-width of 2.45 ms^{-1} should provide 50dB of suppression. The heuristic FFT filter adapts well and chooses the minimum notch half-width required to eliminate most of the clutter signal.

Spectral processing can meet the requirement for lower levels of suppression and smaller reflectivity bias by simply decreasing the width and hunt parameters; in effect, using a smaller notch width. Results of suppression achieved with smaller notch widths are given in Table 6.

PRF (Hz)	Filter	Ns	ΔVc (ms^{-1})	VP (ms^{-1})	Suppression (dB)
322	1220	16	1.06	1.59	7
322	1220	28	1.06	1.59	7.5
1014	1110	52	1.66	0.88	52
1014	1210	88	0.88	1.34	50

Table 6. Suppression Achieved with Smaller Notch Widths.

Use of a smaller notch width results in a smaller reflectivity bias. Reflectivity bias values for varying input widths is given for smaller notch width filters in Table 7.

			Bias (dB) at Input Width (ms^{-1})			
PRF (Hz)	Ns	Filter	1 ms^{-1}	2 ms^{-1}	3 ms^{-1}	4 ms^{-1}
322 Hz	16	1220	6.2	2.1	1.3	0.72
1014	52	1110	0.91	0.22	0.18	0.04

Table 7. Reflectivity Bias with Smaller Notch-widths.

Comparing Table 5 to Table 7 illustrates the significant reduction in reflectivity bias with smaller notch-width and lower suppression. However, the spectral coefficient spacing imposed by the WSR-88D operational requirements makes it difficult to achieve a uniform suppression and bias level with the heuristic filter.

An important operational consideration is the extent of reflectivity bias into the filter pass-band. Meteorological spectra have finite width, that is, finite standard deviation (σ). If the mean velocity is less than 2σ from the stop-band, a portion of the spectra falls in the stop-band and is suppressed. This results in signal loss and reflectivity bias. The

NTR does not address this explicitly; however, it sets bounds through the minimum usable velocity requirement. Reflectivity bias as related to offset velocity is given in Table 8.

					Bias (dB) at Input Width (ms^{-1})			
PRF (Hz)	Ns	Width (ms^{-1})	Filter	Vp(ms^{-1})	1 ms^{-1}	2 ms^{-1}	3 ms^{-1}	4 ms^{-1}
322	16	1	1221	2.65	6.3	2.3	1.2	0
322	16	4	1221	2.65	2.1	0.6	1.2	1
1014	52	1	1221	2.49	22	9.6	1	0
1014	52	4	1221	2.49	0	2	1	0
1014	88	1	1442	3.76	25	21	7	0
1014	88	4	1442	3.76	0.5	0.3	1.2	1

Table 8. Reflectivity Bias as Related to Velocity and Spectral Processing.

One aspect of the spectral filter performance is particularly noteworthy. Note that the bias is large at the narrow spectrum width (1 ms^{-1}) and small velocity offsets (<2 ms^{-1}) but quickly becomes small for larger spectrum widths (4 ms^{-1}) for even small velocity offsets. This behavior results from the spectral coefficient restoration interpolation scheme used in the adaptive filters. This behavior would improve performance of the reflectivity compensation methods presently under development by reducing the compensation required, particularly for the larger spectrum widths at all offsets.

4. Time Domain Clutter Filter Analysis

The SIGMET time domain clutter filter uses a 4th-order Chebyshev Infinite Impulse Response (IIR) high-pass filter. The IIR filter can provide a stop-band attenuation of 40dB or 50dB (user-selectable) and seven stop-band widths. With the standard coefficient sets, the 3dB notch half-width varies from 0.324 ms^{-1} to 2.79 ms^{-1} for the surveillance PRF of 322 Hz and from 1.04 ms^{-1} to 8.78 ms^{-1} for the Doppler PRF of 1014 Hz at the median radar wavelength. At the maximum Doppler PRF of 1282 Hz, the 3dB notch half-width varies from 1.31 ms^{-1} to 11.12 ms^{-1}. The filters and coefficients are described in more detail in the SIGMET Manual [1]. The filter transfer functions, along with the legacy 5th-order IIR filter transfer function are illustrated in Figure 1. Note the sharper transition from stop-band to pass-band achieved with the Legacy 5th-order filter as compared to the SIGMET 4th-order filter.

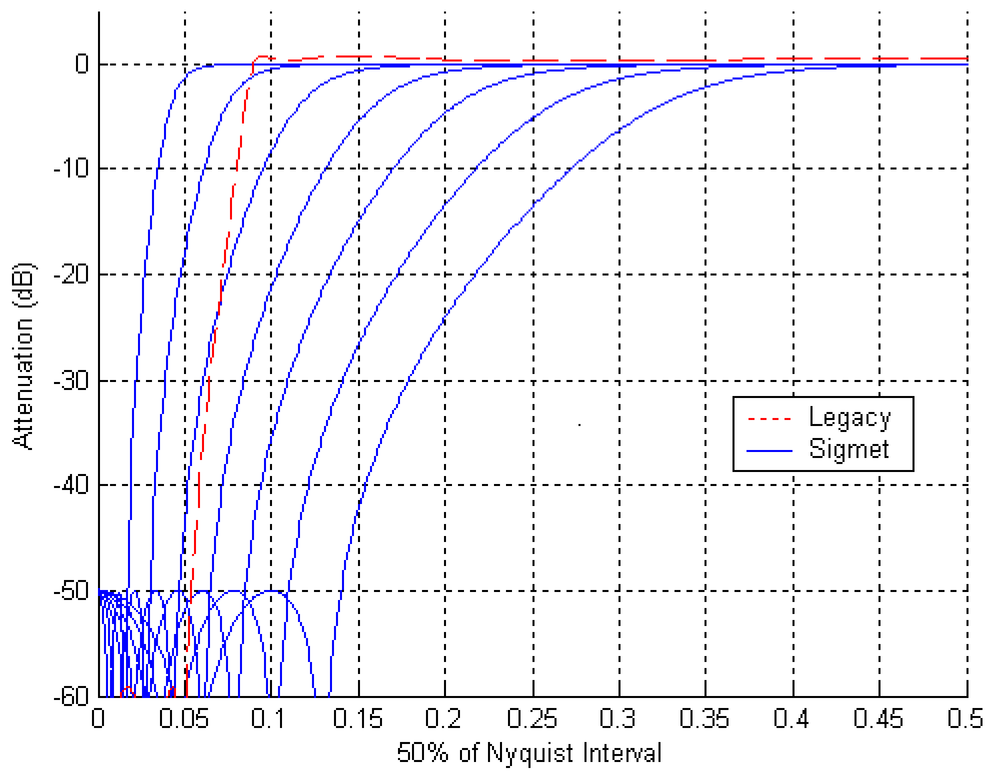

Figure 1. Legacy 5th-Order IIR and SIGMET 4th-Order IIR Transfer Functions

Filter parameters, achieved suppression, and corresponding test conditions are tabulated in Table 9. Surveillance PRF filters 5, 6, and 7 achieve ≥ 50dB suppression. Doppler PRF filters 2 through 7 achieve ≥ 50dB suppression. With the reclusive filter, a 3dB notch half-width greater than 1.8 ms^{-1} will deliver 50dB suppression.

		Surveillance PRF = 322Hz		Doppler PRF = 1014Hz	
Filter	V3dB/Va	V3dB (ms^{-1})	Suppression (dB)	V3dB (ms^{-1})	Suppression (dB)
1	.039	.324	6	1.04	35
2	.075	.634	18	2	52
3	.116	.981	31	3.09	53
4	.164	1.39	43	4.36	52
5	.213	1.80	51	5.61	51
6	.270	2.28	52	7.12	50
7	.330	2.79	52	8.78	50

Table 9. Suppression Achieved with Time Domain Processing.

For Table 9,

Stop-band attenuation = 50dB,

Va = 26.6 ms^{-1} for Doppler = 8.45 ms^{-1} for surveillance,

V3dB = 3dB notch half-width,

Clutter signal width = 0.27 ms^{-1}.

Reflectivity bias as related to input spectrum width for the surveillance PRF is given in Table 10. Figure 2 illustrates the difference in reflectivity bias as related to input spectrum width for the Legacy and SIGMET filters.

		Bias (dB) at Input Width (ms^{-1})			
Filter	V3dB(ms^{-1})	1ms^{-1}	2 ms^{-1}	3 ms^{-1}	4 ms^{-1}
5	1.8	10	5	3	2
6	2.28	14	7	4	3
7	2.79	19	8	5	4

Table 10. Surveillance Reflectivity Bias in Time Domain Processing with Suppression ≥ 50dB.

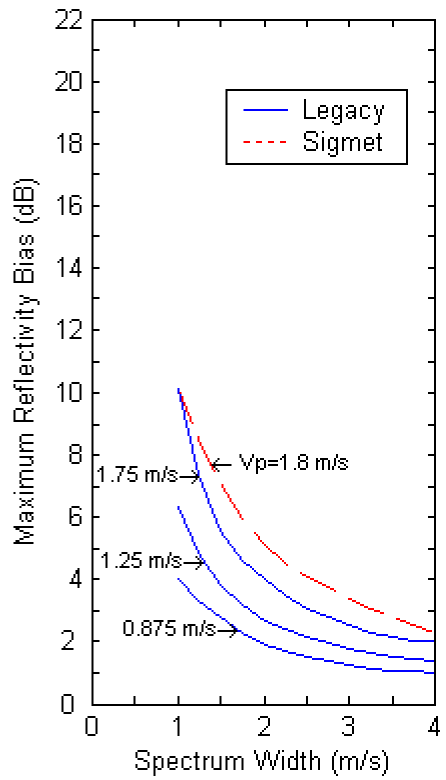

Figure 2. Surveillance Reflectivity Bias v.s. Spectrum Width.

Reflectivity bias as related to input spectrum width for the Doppler PRF is given in Table 11. Figure 3 illustrates the difference in reflectivity bias as related to spectrum width for the Legacy and SIGMET filters.

		Bias (dB) at Input Width (ms^{-1})			
Filter	V3dB(ms^{-1})	1 ms^{-1}	2 ms^{-1}	3 ms^{-1}	4 ms^{-1}
2	2	11	4	3	2
3	3.09	22	8	4	4
4	4.36	32	13	6	6
5	5.67	42	19	9	7
6	7.12	48	26	14	10
7	8.78	49	32	20	13

Table 11. Doppler Reflectivity Bias with Time Domain Processing and Suppression ≥ 50dB.

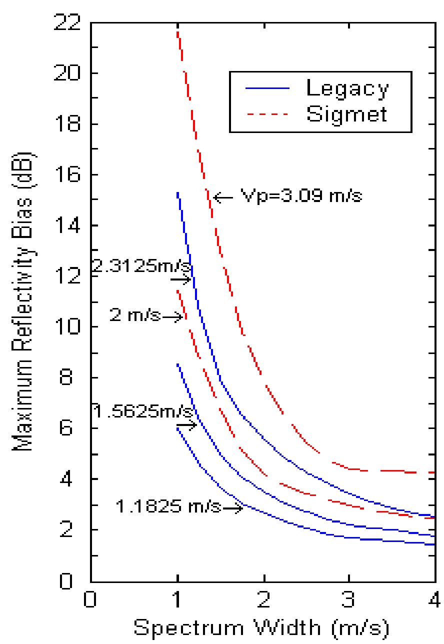

Figure 3. Doppler Reflectivity Bias v.s. Spectrum Width.

Comparing these results with the spectral processing results given in Table 5 reveals the bias is larger at comparable notch widths. The larger bias results from the fact that the time domain transition from stop-band to pass-band is more gradual than the frequency domain transition. The same is true for bias as related to offset velocity (see Table 12 and Table 13). The combination of abrupt transition from stop-band to pass-band and the spectral restoration feature of the spectral processing algorithm reduces the bias quickly with velocity offset. The gradual transition from stop-band to pass-band of the recursive filter extends the bias farther into the passband (See Table 8 for specific values).

		Bias (dB) at Input Velocity (ms^{-1})				
Filter	V3dB (ms^{-1})	Width (ms^{-1})	1 ms^{-1}	2 ms^{-1}	3 ms^{-1}	4 ms^{-1}
5	1.8	1	5	2	0.5	0.6
5	1.8	4	2	1	1	.8
6	2.28	1	7	3	0.8	0.8
6	2.28	4	2	2	1.4	1.0
7	2.79	1	11	5	2	0.9
7	2.79	4	3	3	2	1.4

Table 12. Surveillance Reflectivity Bias as Related to Velocity with Time Domain Processing and Suppression ≥ 50dB.

		Bias (dB) at Input Velocity (ms^{-1})				
Filter	V3dB (ms^{-1})	Width (ms^{-1})	1 ms^{-1}	2 ms^{-1}	3 ms^{-1}	4 ms^{-1}
2	2	1	7	2	1	0.3
2	2	4	2	2	2	2
3	3.09	1	13	7	5	2
3	3.09	4	4	3	2	3
4	4.36	1	21	13	10	5
4	4.36	4	5	4	3	4
5	5.67	1	31	22	16	9
5	5.67	4	7	6	5	6
6	7.12	1	42	33	25	17
6	7.12	4	9	8	7	8
7	8.78	1	48	44	35	26
7	8.78	4	12	11	10	10

Table 13. Doppler Reflectivity Bias as Related to Velocity with Time Domain Processing and Suppression≥ 50dB.

NTR required levels of suppression (Table 1) can be achieved by selecting smaller filter 3dB notch half-widths. As seen from Table 9, the existing SIGMET filter options provide surveillance suppression of 6dB to 50dB with 3dB notch half-width from 0.32 ms^{-1} to 1.8 ms^{-1}. Although the full range of IIR clutter filters were tested and reported here, in practice filters having notch half-widths much greater than 2ms^{-1} for surveillance and 4 ms^{-1} for Doppler would not be used in WSR-88D.

5. Assessment for WSR-88D Applications

Legacy 5^{th}-order IIR Filter - Option 1

The WSR-88D uses a 5^{th}-order high-pass elliptic IIR filter [3]. It is a recursive filter having both signal feed-forward and feedback loops. It has a stop-band depth of 60dB, a pass-band gain of 0.5dB and a pass-band edge velocity (notch half-width) selectable from 0.5 ms^{-1} to 4 ms^{-1} in 0.0625 ms^{-1} steps.

Pass-band edge velocity is operator selectable over the above range or as one of three default values corresponding to low, medium or high suppression modes. The default pass-band edge velocity values are 0.875 ms^{-1} , 1.25 ms^{-1} and 1.75 ms^{-1} for the surveillance filter and 1.1875 ms^{-1} , 1.5625 ms^{-1} and 2.3125 ms^{-1} for the Doppler filter. In the high suppression mode the surveillance filter provides about 62dB suppression with clutter model A and about 52 dB suppression with real data. The Doppler filter will provide about 55dB suppression in the WSR-88D for real clutter. Filter coefficients are automatically changed with radar PRF and wavelength to maintain the specified notch half-width.

An alternate filter need not be designed exactly as the legacy filter. Nevertheless, an alternate design must meet most of the high-level NTR requirements and offer some advantage or improved performance over the legacy filter.

SIGMET FFT Filter - Option 2

As shown previously, the frequency domain filter meets most of the high level requirements of the NTR. This technique also has a distinct advantage over the legacy implementation in that it reduces the reflectivity bias as the signal spectrum moves away from the zero isotach. For signals on the zero isotach, bias as related to spectrum width is essentially the same as the legacy for a given notch half-width. Unfortunately, identical notch width cannot be achieved. The frequency domain filter has significant limitations as noted in discussions regarding Table 3.

Use of the WSR-88D operational PRTs and number of samples in the estimate forces a FFT coefficient spacing of approximately 1.06 ms^{-1} for surveillance mode and approximately 1.66 ms^{-1} to 2.1 ms^{-1} for Doppler mode. The notch width resulting from these incremental choice, results in a filter which, when compared to the legacy, has a larger bias for a given spectrum width on the zero isotach. The heuristic properties of the filter provide spectrum restoration and bias mitigation but also introduce a bias variation that precludes efficient bias compensation. This bias variation increases as coefficient spacing changes with radar PRT.

The WSR-88D operational requirements require specific spectral coefficient spacing increments for a PRT; Thereby resulting in a limited choice of filter notch widths. The WSR-88D operational requirements also require an user-selectable, variable notch width by PRT. With variable notch-widths, the filter will not achieve a uniform suppression and bias level within the VCP. As a result, post-processing can not correct for the clutter suppression and bias effects. Therefore, the frequency domain filter is not recommended for routine operational use in the ORDA.

SIGMET 4^{th}-order IIR Filter - Option 3

As shown previously, the 4^{th}-order IIR filter meets most of the high level requirements of the NTR. As may be expected, the 4^{th}-order time domain filter performance is very similar to the 5^{th}-order legacy filter. The primary differences are due to the more gradual transition from the stop-band to pass-band of the 4^{th}-order filter. Maximum suppression is approximately equivalent between the SIGMET and Legacy filters. Bias, at zero velocity, is essentially the same between the two filters for narrow widths (1 ms^{-1}) and large widths (4 ms^{-1}). However, at intermediate widths (2 ms^{-1} to 3 ms^{-1}), the 4^{th}-order filter bias is approximately 1 dB larger. The 4^{th}-order filter reflectivity bias also extends farther into the pass-band than the 5^{th}-order filter but the increase is not large (typically around 1 dB).

The overall performance of the 4^{th}-order filter is comparable to the legacy. Its design allows for PRF-independent notch widths and consistent suppression and bias levels required for reflectivity bias compensation. Use of the 4^{th}-order filter would require considerable effort. The seven notch widths offered with SIGMET's signal processing software are not adequate for the WSR-88D application. The legacy design has 55 notch-widths (i.e. 55 sets of filter coefficients) for each PRF – a total of 440 coefficient sets for the 8 PRFs. Additionally, the system must include the logic to automatically select or generate the proper set by radar wavelength and PRF. Even if the notch width selection increment were increased from 0.0625 ms^{-1} to 0.1 ms^{-1}, (an increment of 0.1 ms^{-1} = about 30% of the typical ground clutter width) some 280 sets of coefficients would still be required.

Given that the 4th-order filter has a larger reflectivity bias than the legacy's filter and that considerable adaptation effort is still required for notch-width selection, the 4th-order filter is not recommended for routine operational use in the ORDA

6. Recommendation

It is recommended that the legacy IIR 5th-order filter be implemented in the ORDA.

References

[1] SIGMET RVP7 User's Manual April 2002

[2] NEXRAD Technical Requirements January 1986 R400 SP 301

[3] Clutter Filtering In The WSR-88D, OSF Internal Report, October 1992